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DEVELOPMENT OF A 360° VIRTUAL REALITY-BASED ANDROID APPLICATION FOR CAMPUS INTRODUCTION AT WASTUKANCANA COLLEGE OF TECHNOLOGY USING MDLC METHOD

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ABSTRAK

Perkembangan teknologi informasi telah mendorong pemanfaatan media digital interaktif dalam bidang pendidikan, termasuk untuk kegiatan pengenalan kampus. Salah satu pendekatan yang potensial adalah Virtual Reality (VR) dengan tampilan panorama 360°, yang memungkinkan pengguna mengeksplorasi lingkungan secara imersif tanpa harus hadir secara fisik. Penelitian ini bertujuan untuk mengembangkan aplikasi Virtual Reality Tour 360° berbasis Android sebagai media pengenalan kampus Sekolah Tinggi Teknologi Wastukancana bagi mahasiswa baru. Pengembangan dilakukan dengan metode *Multimedia Development Life Cycle* (MDLC) melalui enam tahap utama: konsep, desain, pengumpulan materi, pembuatan, pengujian, dan distribusi. Fitur utama aplikasi meliputi navigasi berbasis hotspot, narasi audio otomatis berbasis text-to-speech, serta mode stereoscopic yang kompatibel dengan Google Cardboard. Aplikasi juga memanfaatkan sensor gyroscope untuk menyesuaikan arah pandang pengguna. Hasil pengujian menggunakan metode blackbox terhadap 177 skenario fungsional menunjukkan tingkat keberhasilan 100%. Keunikan aplikasi ini terletak pada integrasi audio narasi dan dukungan mode VR sederhana berbasis cardboard yang memberikan pengalaman tur virtual lebih interaktif dan realistis. Dengan demikian, aplikasi ini dinilai efektif sebagai media pengenalan kampus digital yang informatif, praktis, dan inovatif.
Kata kunci: Virtual tour, panorama 360, sensor gyroscope, stereoscopic, MDLC

ABSTRACT

Advances in information technology have encouraged the use of digital interactive media in education, including for campus orientation activities. One potential approach is Virtual Reality (VR) with a 360° panoramic view, which allows users to explore an immersive environment without having to be physically present. This research aims to develop an Android-based 360° Virtual Reality Tour application as an introduction to the Wastukancana College of Technology campus for new students. Development was conducted using the Multimedia Development Life Cycle (MDLC) method, encompassing six main stages: concept, design, material collection, creation, testing, and distribution. The application's key features include hotspot-based navigation, automatic text-to-speech audio narration, and a stereoscopic mode compatible with Google Cardboard. The application also utilizes a gyroscope sensor to adjust the user's viewing direction. Black-box testing results on 177 functional scenarios demonstrated a 100% success rate. The application's uniqueness lies in the integration of audio narration and support for a simple cardboard-based VR mode, which provides a more interactive and realistic Virtual tour experience. Therefore, this application is considered effective as an informative, practical, and innovative digital campus orientation medium.
Keywords: Virtual tour, 360 panorama, gyroscope sensor, stereoscopic, MDLC

1. INTRODUCTION

The rapid development of information technology has had a significant impact on the education system. In addition to facilitating access to various learning resources, technology also encourages innovation in teaching methods. One of the innovations that has been increasingly adopted is Virtual Reality (VR), which enables users to experience learning in an interactive and immersive way without being physically present at a particular location. Through this technology, students can explore virtual environments that resemble the real world, thereby enhancing understanding and engagement in the learning process [1]. One of the applications of this technology is the Virtual Reality Tour, which allows

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users to explore locations virtually using a computer or smartphone. Through this approach, users can obtain information and visualizations of the campus environment in a more detailed, interactive, and immersive manner [2]. A 360° Virtual Tour itself is a digital representation of a real location consisting of panoramic photos, images, or videos that are interconnected through hyperlinks, and may even include virtual models of the actual place [3].

Along with technological advancements, educational institutions are increasingly relying on various promotional methods to attract prospective students. Each semester, universities open enrollment for new students and carry out promotional activities through print media as well as social media. To capture the interest of prospective students, promotions are typically conducted by showcasing campus facilities in brochures. In addition, at the beginning of the semester, universities also organize orientation activities to introduce the campus environment to new students [4].

One of the common activities conducted is a campus tour, which serves as a direct introduction to the campus environment for prospective students, parents, and other stakeholders. Although effective, this method has certain limitations, particularly for prospective students who live far away. Time and financial constraints often become the main obstacles to participating in an on-site campus tour [5]. S After the enrollment process is completed, students are also required to participate in the PKKMB (Pengenalan Kehidupan Kampus bagi Mahasiswa Baru / Introduction to Campus Life for New Students) program. However, many of them are still unfamiliar with the locations of buildings or faculties within the campus environment [6]. Wastukancana College of Technology Purwakarta is one of the higher education institutions in Purwakarta Regency that organizes the PKKMB program every year. However, new students often face difficulties in recognizing lecture buildings, facilities, and other important areas. The information delivered through conventional methods has limited effectiveness; therefore, a more interactive and easily accessible technological solution is required.

Previous studies have shown that Virtual Tours can serve as an effective learning medium, as demonstrated in the implementation at the Siginjei Museum for introducing historical and cultural materials. This technology has been proven to enhance interaction, improve understanding, and provide an engaging exploration experience [7].

Nevertheless, most prior studies remain limited to the presentation of visual panoramas without additional interactive features. Few studies have integrated automatic audio narration to guide users during exploration, nor have they optimized the gyroscope sensor to adjust the viewing direction in real time. Furthermore, Android-based developments supporting stereoscopic modes through Google Cardboard are still rarely carried out, particularly for campus orientation purposes aimed at new students.

Based on these conditions, this study offers a new contribution in the form of a 360° Virtual Reality Tour Android application equipped with automatic audio narration, gyroscope-based navigation, and compatibility with Google Cardboard. The aim of this study is to develop and evaluate the effectiveness of the application as an interactive, informative, and easily accessible campus introduction medium at Wastukancana College of Technology. In addition, it is expected to assist the institution in providing campus orientation information in a more interactive and efficient manner for new students.

2. MATERIAL AND METHODS

Research methods

This study employed the Multimedia Development Life Cycle (MDLC) as the primary approach in application development. MDLC was chosen because it is well-suited for the development of multimedia applications that integrate images, audio, video, and interactive elements. In addition, this method provides a structured sequence of stages, ranging from planning to distribution, thereby facilitating the development of educational multimedia-based applications. MDLC consists of six stages: concept, design, material collection, assembly, testing, and distribution. Through these stages, the application can be systematically developed by considering user requirements, interactive design, material integration, and validation through functional testing [8].

Stages of the Multimedia Development Life Cycle Method

The MDLC method consists of six stages, namely concept, design, material collection, manufacturing, testing, and distribution [9]. These stages are shown in Figure 1.

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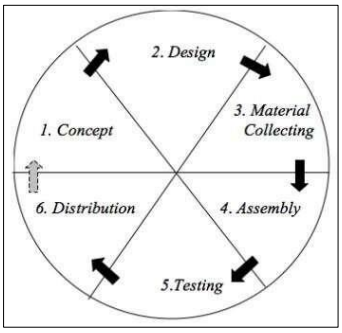

Figure 1. Multimedia Development Life Cycle Method

1. Concept
   At the concept stage, this application was designed as a campus introduction medium for Wastukancana College of Technology by applying Virtual Reality technology in the form of an Android-based 360° Virtual Tour. Virtual Reality technology enables users to experience a virtual environment immersively as if they were physically present at the actual location [10]. The app displays a series of 360 panoramas linked to key locations on campus, complete with interactive hotspots for switching scenes and click-through information on various rooms [11]. To create a three-dimensional visual experience, the app uses a stereoscopic technique with a side-by-side format, where two images are displayed side by side for the left and right eyes to create a depth effect [12]. This application was developed using Unity 2021.3.45 LTS and is designed to be compatible with Android devices and supports the use of Google Cardboard as a Virtual Reality display medium.
2. Design
   At this stage, the user interface (UI) was designed, including the splash screen, 360° panoramas, and navigation buttons, which were adapted to the results of campus environment observations at Wastukancana College of Technology. To illustrate the logical flow of the application, a flowchart was developed to present program steps systematically, thereby facilitating the implementation process [13]. In addition, a storyboard was prepared in the form of a sequence of images representing the display and interaction flow between application pages, making the development process more structured [14].
3. Material Collecting
   The material collection was carried out by capturing 360° panoramic photos of key areas such as buildings and rooms. Supporting information, including the campus profile, logo, social media accounts, and other visual elements required to enrich the application content, was also compiled for the Virtual Tour application.
4. Assembly
   The application development was carried out using Unity 2021.3.45 LTS, a real-time development platform widely used for creating cross-platform 3D interactive simulations and experiences [15]. At this stage, all collected materials were integrated with C# programming. The C# scripts were designed to manage navigation through hotspots, panorama rotation based on the gyroscope sensor, activation of stereoscopic mode with Google Cardboard, and automatic audio narration. Technical challenges encountered included differences in gyroscope sensitivity across devices and variations in text-to-speech output on different Android versions. These issues indicate that panorama accuracy and audio consistency remain dependent on the specifications of the user's device.
5. Testing
   Testing was conducted to ensure that all features of the 360° Virtual Reality Tour application for Wastukancana College of Technology functioned properly. The method used was blackbox testing, a software testing approach that evaluates execution results without considering the internal code structure, focusing instead on application functionality [16]. The testing process covered navigation between panoramas through hotspots, interactions with a Bluetooth controller, and stereoscopic display using Google Cardboard on Android devices.
6. Distribution
   Following testing, the APK file was distributed via GitHub and Google Sites so that it could be accessed by new students. Feedback obtained from users was then used for improvements and further development.

Research Flow

In addition to referring to the MDLC stages, this study was also carried out through four main steps: data collection, preparation of research tools, application development, and preparation of the final report. Data collection was conducted through literature studies and direct observations in the campus environment. Tool preparation included the configuration of hardware and software used during the development process. The core stage was the development of the application based on the MDLC method, and all research activities were documented in the form of a scientific report. The overall research flow is illustrated in Figure 2.

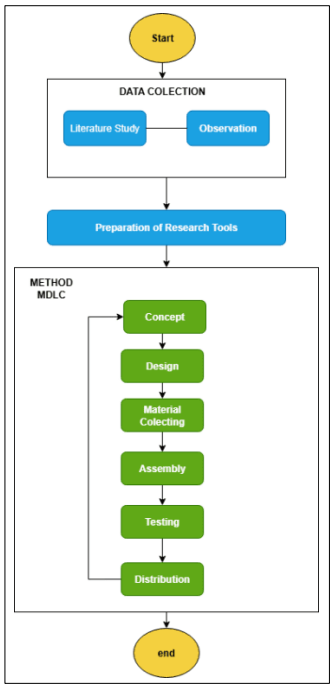

Figure 2. Research Flow

Data Collection

The data in this study were obtained through two methods, namely literature study and observation. Both methods were employed to support the design and development process of the 360° Virtual Tour application, as described in the following subsections.

1. Literature Study
   The literature study was conducted by reviewing various relevant reference sources, such as books, scientific journals, articles, and online resources related to multimedia application development, virtual reality technology, and the MDLC method. The purpose of this literature study was to obtain theoretical insights and fundamental concepts that would serve as the foundation in the design and development process of the application.
2. Observation
   The observation was carried out directly in the campus environment of Wastukancana College of Technology, covering key locations such as the main gate, administration office, classrooms, laboratories, library, auditorium, prayer room, canteen, parking area, and campus yard. The selection of locations was based on their relevance to the academic activities of new students as well as their strategic functions in campus life. This observation also involved lecturers and students as stakeholders to ensure that the chosen locations met user needs, thereby making the collected visual data and contextual information more accurate.

Preparation of Research Tools

The development of the 360° Virtual Tour application utilized several tools and supporting materials for the design, implementation, and testing processes. The following are the details of the tools and materials used:

1. Hardware Specifications
   The selection of appropriate hardware plays an important role in supporting the development and simulation of VR, both from the developer's side and the end-users. The hardware specifications used in this study are presented in Table 1.

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Table 1. Hardware Requirements Specifications

No	Device	Specification or Description
1	Laptop or Computer	AMD Ryzen 3 processor, 20 GB RAM, SSD as the primary storage, Windows 11 64-bit operating system.
2	Smartphone	Supports 360° panoramic image capture for visual documentation purposes.
3	Google Cardboard	Used to display Virtual Reality content to users.
4	Bluetooth Controller	Used as a navigation tool when using Google Cardboard.

2. Software Specifications

In addition to hardware, software also plays an important role in supporting the development of VR applications. The software specifications used in this study are presented in Table 2.

Table 2. Software Specifications

No	Software/Tool	Specification or Description
1	Operating System	Windows 11 Home Single Language 64-bit
2	Unity 2021.3.45 LTS	The main platform for building and developing the Android-based 360° Virtual Tour application
3	Unity Asset Store	Used to download additional plugins such as the 360 Photo Viewer
4	360 Photos (APK)	Android application for capturing 360° panoramic images during the visual data collection stage
5	GitHub & Google Site	Used as a distribution platform for APK files to users

3. RESULT AND DISCUSSION

Concept

The main concept implemented in this application is the introduction of Wastukancana College of Technology through an Android-based 360° Virtual Tour. The application displays 360-degree panoramas of various important campus locations, which users can explore interactively through hotspot-based scene navigation. Each panorama is equipped with navigation buttons and relevant room information. To support an immersive display, a stereoscopic side-by-side technique is applied, allowing the view to be split into left and right perspectives. The application concept is illustrated in Figure 3.

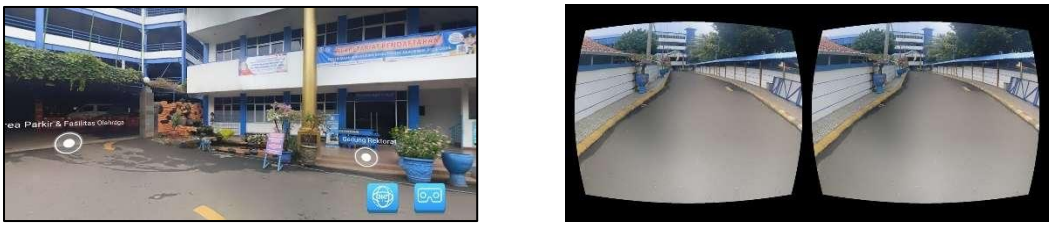

Figure 3. Hotspot Point and Side by Side VR

The application is designed to be used with Google Cardboard devices, and is developed using Unity 2021.3.45 LTS and the C# programming language. The choice of C# is based on the fact that this language is the main language in Unity, making it more flexible and efficient in managing interactions, navigation, and multimedia integration within the application.

Design

The logical flow of the application is visualized through a flowchart diagram that illustrates the sequence of user interactions, starting from the main menu display to the exploration of panoramas. This diagram helps ensure that each process runs in a structured manner in accordance with the development objectives. The detailed flow is presented in Figure 4.

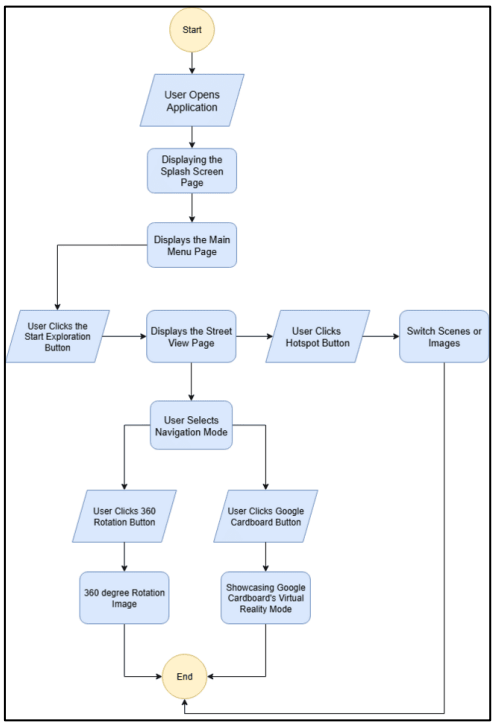

Figure 4. Application Flowchart

Meanwhile, the design of the user interface and scene transitions is illustrated in the form of a storyboard. Each frame depicts the UI elements, navigation button positions, and the sequence of page transitions. This storyboard serves as a visual reference in the design implementation process and is presented in Figures 5, 6, 7, 8, and 9.

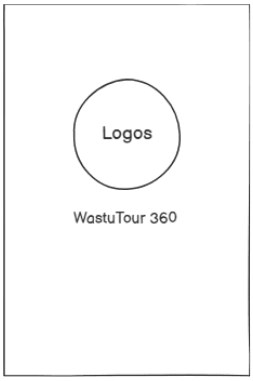

Figure 5. Scene 1

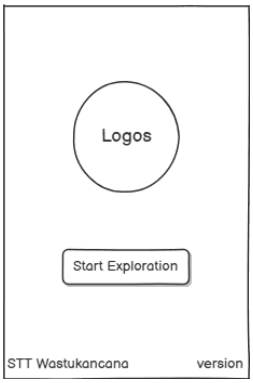

Figure 6. Scene 2

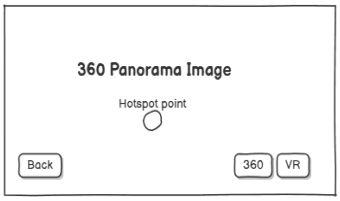

Figure 7. Scene 3

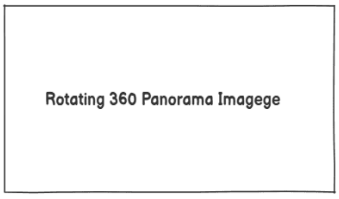

Figure 8. Scene 4

Figure 9. Scene 5

Description:
Scene 1, Displays the application introduction in the form of a splash screen that appears before the user enters the main menu.
Scene 2, After passing through the splash screen, the user is directed to the main menu of the application, which contains a single button, “Start Exploration”, that navigates the user to the Streetview scene.

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Scene 3, Presents a 360° exploration view equipped with three buttons: Back, 360 mode, and VR mode. In addition, there are interactive hotspots that function as connectors between locations or scenes within the campus tour.
Scene 4, Shows a 360° image with automatic rotation without displaying any navigation buttons, allowing users to enjoy the view more comfortably and with focus.
Scene 5, Represents the Virtual Reality (VR) mode using Google Cardboard, where the screen is divided into two parts to create a stereoscopic effect. In this mode, users can experience immersive 360° panoramic exploration with a physical cardboard device.

Material Collecting

The main materials collected consisted of 360° panoramic photos from various key points within the Wastukancana College of Technology campus, such as the front yard, classrooms, laboratories, and the auditorium. These images served as the primary background in the application scenes. In addition, supporting visual assets were also gathered, including the official campus logo, social media links, and a brief institutional profile to be displayed in the information menu. All of these materials were then organized and optimized to meet the requirements of the Android-based 360° Virtual Tour application development.

Assembly

The development phase is the process of transforming a design plan into a real-world application. Development is carried out using Unity3D software as the primary platform.

1. Splash Screen
   The splash screen serves as the initial visual identity of the application. In this scene, the Wastu Tour 360 logo is displayed against a blue background, designed using Canvas and Image in Unity in portrait mode. The transition to the main menu is carried out automatically after a few seconds through a timer script. The splash screen design is shown in Figure 10.

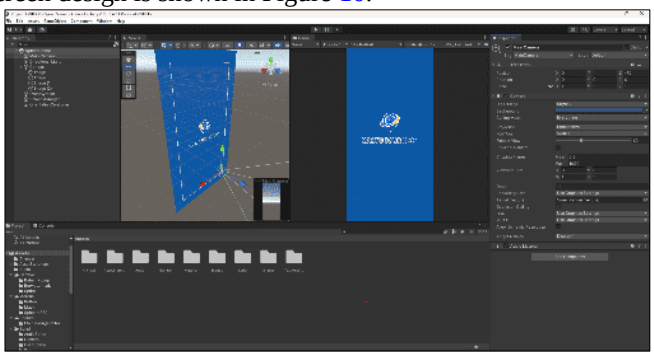

Figure 10. Making Splash Screens

2. Main Menu Page
   The Main Menu page serves as the initial user interaction screen before entering the virtual tour. The background displays a campus panorama along with the WastuTour 360 logo, a Start Exploration button, and application version information at the bottom. The UI is designed in portrait mode using Canvas, and the main button directs the user to the exploration scene (Figure 11).

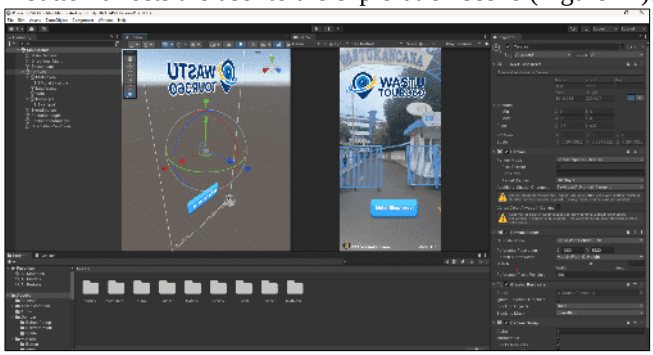

Figure 11. Main Menu Page Creation

3. Street View Page
   The Street View page is a continuation of the Main Menu, displaying a 360-degree panorama of the campus in landscape mode. This scene is equipped with navigation buttons, interactive hotspots for

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moving between locations, and automatic audio narration using the Livna voice through the text-to-speech feature. The scene design is shown in Figure 12.

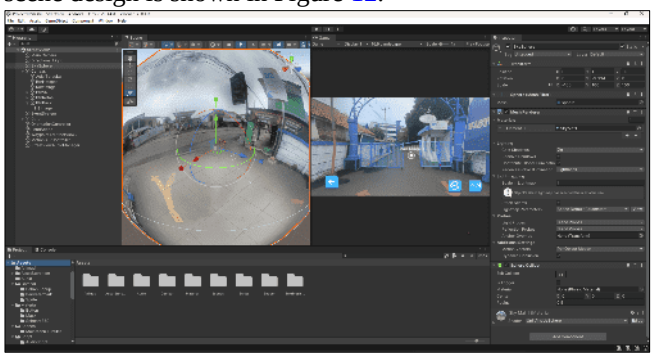

Figure 12. Street View Page Creation

4. 360° Rotation page
   The 360° Rotation page displays a campus panorama that rotates automatically. Users can control the rotation by pressing the on/off button available on the screen. This page is shown in Figure 13.

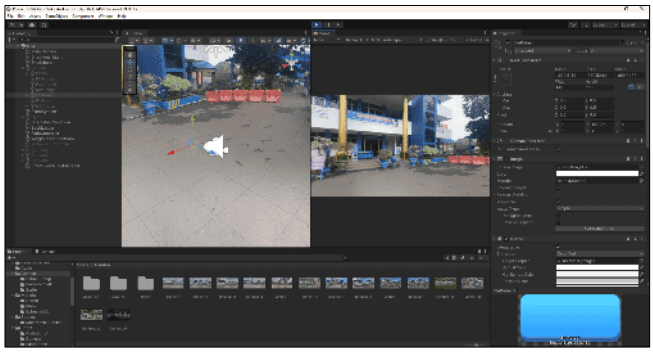

Figure 13. Creating a 360 Rotation Page

5. Google Cardboard VR Mode Page
   The VR Mode page displays a 360° panorama in a dual-screen stereoscopic format compatible with Google Cardboard. By utilizing a dual-camera system, users can explore the campus immersively in virtual reality mode. The design of this page is shown in Figure 14.

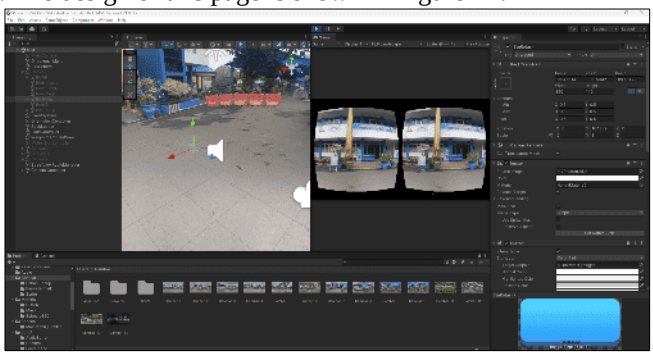

Figure 14. Creation of Google Cardboard Pages

Testing

Application testing was carried out using the black-box testing method to ensure that all functions operated as designed. The trials were conducted directly on Android devices by evaluating the system's response to user actions without considering the internal code structure. In this testing, a total of 177 test scenarios (test cases) were applied, covering panorama navigation through hotspots, rotation button functionality, scene transitions, stereoscopic display for Google Cardboard, and interaction with the Bluetooth controller. The test results showed that all functions performed successfully, achieving a 100% success rate.

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Distribution

After the APK file was distributed through GitHub and Google Sites, the application was successfully downloaded and run by several new students. Their independent trials indicated that the application could be used smoothly across various Android devices. The initial feedback stated that the panoramic views were visually appealing, the navigation was easy to understand, and the Google Cardboard feature provided an immersive exploration experience. The feedback obtained served as the basis for evaluation and improvement in the next version.

4. CONCLUSIONS

Based on the development and testing results, the Android-based 360° Virtual Tour application for introducing Wastukancana College of Technology was successfully developed using the Multimedia Development Life Cycle (MDLC) method. The application presents interactive panoramas that allow users to explore the campus environment immersively through hotspot navigation, audio narration, and Google Cardboard support. Testing using the black-box method with 177 scenarios demonstrated that all features functioned as designed with a 100% success rate.

This study contributes to providing an innovative Virtual Reality–based digital solution for campus introduction in a more interactive and flexible manner, offering benefits particularly for new students and the institution in delivering orientation information in a modern and efficient way. In the future, further development may focus on adding additional interactive features and conducting user experience–based evaluations to enhance the usability and effectiveness of the application.

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